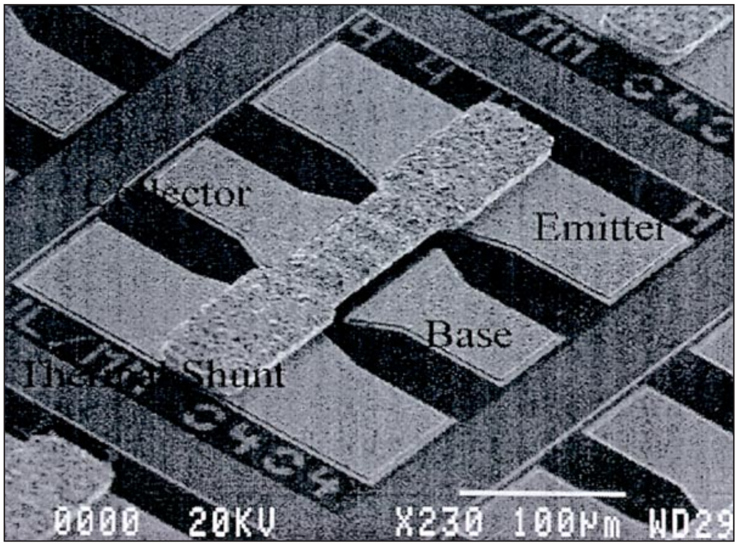
# NEW THERMALLY SHUNTED HETEROJUNCTION BIPOLAR TRANSISTOR TRANSFERRED TO INDUSTRY






## Payoff

The new thermally shunted heterojunction bipolar transistor translates into smaller power devices that can save space and energy on airborne platforms. It is being used by industry to make power amplifiers for Air Force X-band radar and to produce more efficient cellular phones.

## Accomplishment

A thermally shunted heterojunction bipolar transistor (TSHBT), invented by a team of Sensor Directorate engineers, has solved the thermal wall limitation problem of conventional HBTs. This breakthrough translates into a TSHBT that is 500 percent more powerful and 78 percent more efficient.

## Background

Power to run a X-band radar is provided by power amplifiers containing thousands of 2-micron wide HBT devices. These tiny devices can produce around 3 milliwatts per square micron (mW/micron$^2$) of power with the limit being driven by the amount of waste heat generated by the HBTs. This limit is significant because the amount of power, the size of the HBTs and the amount of heat generated pose a challenge to scientists by combining to dictate the design of the power amplifiers. The Air Force and industry both require more efficient, powerful and cooler operating power amplifiers. To address this challenge, the Directorate's team, led by Chris Bozada, invented a thermal shunt in 1994 that is applied to the surface of a HBT. It acts to distribute the heat produced by the HBT over a wider area making the individual HBTs cooler. Operating cooler means that the power and efficiency both increase dramatically. Applying the initial thermal shunt design increased the power output to 10mW/micron$^2$, a 300 percent increase over the conventional HBT. This result was outside of the theoretical limits of the HBT basic design. The TSHBT, an entirely new device with new operating boundaries, is capable of producing over 16mW/micron$^2$. The team also discovered that the TSHBT could be built up to 16 microns in diameter, an 800 percent increase in size. The larger devices are more powerful, easier to build, and simpler to use than the earlier 2 micron devices.